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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to an ink jet head, a manufacturing method for the same, a nozzle formation member, and a manufacturing method for the same.
[0002]
[Description of the Prior Art]In the ink-jet recording device generally used as image forming devices, such as a printer, a facsimile, and a reproducing unit, Two or more nozzles which carry out the regurgitation of the ink droplet, and the liquid flow channel formation member which forms the liquid flow channel (called a pressurized room, a regurgitation room, an application-of-pressure fluid chamber, a pressure chamber, an ink chamber, a fluid chamber, etc.) which each nozzle opens for free passage, Electric machine sensing elements, such as a piezoelectric element which generates the energy for pressurizing the ink in each liquid flow channel, and making an ink droplet breathe out from a nozzle, Or the ink jet head provided with the energy generation means (actuator element) which consists of electrostatic force generating means, such as electric heat transfer devices, such as a heater, or an electrode, and a diaphragm, etc. is carried, An ink droplet is made to breathe out from a necessary nozzle by driving the actuator element of this head according to picture information, and a picture is recorded.
[0003]In order that the ink jet head of such an ink-jet recording device may record by carrying out regurgitation flight of the drop-ized ink from a nozzle by driving an energy generation means, The shape of a nozzle hole and accuracy affect the jetting properties of an ink droplet, and the surface characteristic of the nozzle formation member which forms the nozzle hole affects the jetting properties of an ink droplet. For example, when ink adheres to the nozzle hole periphery on the surface of a nozzle formation member (ink discharge side) and uneven ink **** arises, there is inconvenience, like the jet direction of an ink droplet is bent, the size of an ink droplet shows dispersion, or the flight speed of an ink droplet becomes unstable.
[0004]Then, the method of protecting from the former that uneven ink **** occurs by providing the surface layer (film) which has water repellence (ink repellency) in the surface of a nozzle formation member is known. for example, the method (JP,55-65564,A.) of applying water repellents, such as silicon system water repellent and fluorine system water repellent How to carry out a surface treatment by refer to JP,9-76512,A, fluoro alkoxysilane, etc. (refer to JP,56-89569,A), How to form the plasma polymer of a fluorine system compound or the Silang system compound (refer to JP,64-87359,A), There are the method (refer to JP,63-3963,A, JP,4-294145,A, JP,7-125220,A, JP,7-52382,A, and JP,8-244235,

A) of forming a water-repellent membrane by fluorine system polymers eutectoid plating, etc.
[0005]These various conventional nozzle formation members and manufacturing method for the same are explained with reference to drawing 12 or subsequent ones.
(Conventional technology 1) If the manufacturing method of a general nozzle formation member and a water-repellent surface layer using electroforming is explained with reference to drawing 12, As shown in the figure (a), the organic resist 102 is patterned after the part which is equivalent to a nozzle hole on the substrate 101 which has conductivity, after forming the metal membrane 103 which serves as a nozzle formation member with electroforming further isotropic, as shown in the figure (b), the metal membrane 103 is exfoliated and a nozzle formation member is obtained. In this case, that from which the opening which had touched the substrate 101 side serves as the ink discharge opening 107, and the opening which faces it serves as the ink flow entrance 108 (refer to the figure (e)) is common. It uses as a term as which an "ink discharge opening" means the ink discharge side side opening of a nozzle hole, and an "ink flow entrance" means the ink flow ON side (fluid chamber side) side opening of a nozzle hole.
[0006]Then, as shown in the figure (c), after carrying out the seal of the metal membrane 103 surface by the sealing member 104, as shown in the figure (d), After being filled up with organic layer 105 grade from the ink flow entrance 108 side, the sealing member 104 is removed, Electrolysis forms in the metal membrane 103 surface the water-repellent surface layer 106 which consists of metal and an eutectoid plating film of polytetrafluoroethylene (henceforth "PTFE") with ** plating etc., and as shown in the figure (e), the organic layer 105 is removed, The nozzle formation member 103 which has the water-repellent surface layer 106 is completed.
[0007]If the manufacturing method of the (conventional technology 2) next the nozzle formation member indicated by JP,63-3963,A, and a water-repellent surface layer is explained with reference to drawing 13, the releasing layer 202 will be formed on the substrate 201, and also the dry film resist 203 will be patterned after the part equivalent to a nozzle hole. And as shown in the figure (b), after forming the metal membrane 103 which serves as a nozzle formation member by the method in a Mister, The water-repellent surface layer 106 which consists of a metal plating layer which contained tetrafluoride resin continuously is formed, as shown in the figure (c), the releasing layer 202 and the substrate 201 are removed, and the nozzle formation member 103 which has the water-repellent surface layer 106 is completed.
[0008]If the nozzle formation member currently indicated by the (conventional technology 3), next JP,62-234941,A and JP,10-16236,A is explained with reference to drawing 13, as shown in the figure (a), After patterning the organic resist 102 after a part corresponding on the substrate 101 which has conductivity in a nozzle hole, the organic resist film 301 is patterned on the organic resist 102 with the size of the ink flow ON side side opening diameter (diameter of a delivery).
[0009]And as shown in the figure (b), the metal membrane 103 which serves as a nozzle formation member with electroforming is formed isotropic. However, in the part which is equivalent to a nozzle hole unlike the conventional technology 1 mentioned above, the organic resist film 301 specifies the direction of deposition of the metal membrane 103. Then, as shown in the figure (c), the metal membrane 103 is exfoliated from the substrate 101, and the organic resist 102 and the organic resist 301 are removed. It is the same as that of the above-mentioned conventional technology 1 that the opening which had touched the substrate 101 side also in this case serves as the ink discharge opening 107, and the opening which faces it serves as the ink flow entrance 108.

[0010]Subsequently, as are shown in the figure (d), and the seal of the metal membrane 103 surface is carried out by the sealing member 104 and it is shown in the figure (e), After being filled up with organic layer 105 grade from the ink flow entrance 108 side, the sealing member 104 is removed, and the water-repellent surface layer 106 which consists of metal and an eutectoid plating film of PTFE by an electrolysis eutectoid plating method etc. is formed in the metal membrane 103 surface. Then, as shown in the figure (f), the organic layer 105 is removed and the nozzle formation member 103 which has the opportunity aquosity surface layer 106 is completed.
[0011]When the nozzle formation member currently indicated by the (conventional technology 4), next JP,1-74142,U is explained with reference to drawing 15, this nozzle formation member, The step 402 which makes the opening diameter by the side of the ink discharge opening 401 smaller than the opening diameter by the side of the ink flow entrance 403 is formed in the inner skin (internal surface) of the nozzle hole 400 on a piece reason.
[0012]The nozzle hole 400 of this nozzle formation member of the inner periphery tangential direction and ink discharge direction by the side of an ink discharge side (upper part) is parallel, and its inner periphery tangential direction and ink discharge direction by the side of an ink flow ON side (lower part) are also parallel. That is, the inner periphery of the upper part and the lower part is parallel, and the step 402 which connects the upper part and the lower part is keen (henceforth "nonsequential").
[0013]If the nozzle formation member currently indicated as the (conventional technology 5), next conventional technology of JP,10-16236,A, etc. is explained with reference to drawing 16, This nozzle formation member is produced by press working of sheet metal etc., and, in the nozzle hole 500, the opening diameter by the side of the ink discharge opening (surface) 501 has become smaller than the opening diameter by the side of the ink flow entrance (rear face) 503, And although the angles which an ink discharge direction and the tangential direction of nozzle hole inner skin make differ by the ink discharge side and ink flow ON side side in the arbitrary parts 502, it is nonsequential in the part 502 where an angle changes.
[0014]
[Problem(s) to be Solved by the Invention]If it is in a nozzle formation member of the conventional technology 1 mentioned above, and a manufacturing method for the same, As shown in drawing 12 (e), since formation of the nozzle hole by electroforming is isotropic if the path of xmum and the ink discharge opening 107 is set to ymum, the path of the outline of the ink flow entrance 108 serves as 2 x +ymum in the thickness of the metal membrane 103. Therefore, if the making narrow pitch between adjoining nozzle holes required in order to perform record of a high speed and high resolution is difficult, and thickness xmum of a metal membrane (nozzle formation member) is made small in order to attain a making narrow pitch, the yield on production will fall and the reliability of a nozzle formation member will also fall.
[0015]If it is in a nozzle formation member of the conventional technology 2, and a manufacturing method for the same, the outer diameter in the upper arbitrary parts of the dry film resist 203 formed by the thickness of the thickness of a metal membrane turns into the path ymum of an ink discharge opening, and the outer diameter of the dry-film-resist 203 bottom turns into a path of an ink flow entrance.
[0016]Here, when making thickness of the metal membrane used as a nozzle formation member into the practically suitable thickness, for example, 50-100 micrometers, the above-mentioned dry film resist must be vertically exposed and developed with a photo-engraving process by the thickness beyond it. In

order that the upper surface of a dry film resist may specify the path of an ink discharge opening at this time, control of that path must carry out with high precision. In order to perform record of a high speed and high resolution especially, control of a nozzle diameter is important, but. As mentioned above, it is difficult to control the path of a dry film resist by the part of 50-100-micrometer height with high precision, and variation arises in the expulsion-of-an-ink-droplet characteristic (ink droplet jetting properties), and the yield falls [a manufacture top].

[0017]If it is in a nozzle formation member of the conventional technology 3, and a manufacturing method for the same, Although it does not have a problem like the conventional technologies 1 and 2 mentioned above, after forming a sealing member on a nozzle formation member like the conventional technology 1, it must be filled up with an organic layer etc. in a nozzle hole, and a construction method with a long routing counter of forming a water-repellent surface layer must be taken. Therefore, the yield falls and a manufacturing cost becomes high.

[0018]Next, since it is easy to generate the loss of the energy which it is easy to produce cellular **** in this step at the time of ink discharge, and is transmitted from an energy generation means in a step since it is nonsequential in the step in a nozzle hole if it is in the nozzle formation member of the conventional technology 4, the expulsion-of-an-ink-droplet characteristic falls.

[0019]Even if it is in the nozzle formation member of the conventional technology 5, in order that nozzle hole inner skin may change to a discharge direction nonsequetially, it is easy to generate the loss of the energy transmitted from an energy generation means, and the expulsion-of-an-ink-droplet characteristic falls.

[0020]It aims at providing the manufacturing method of the nozzle formation member which this invention is made in light of the above-mentioned problems, can plan a narrow pitch, and provides the good nozzle formation member and ink jet head of the expulsion-of-an-ink-droplet characteristic, and can manufacture this nozzle formation member with the sufficient yield.

[0021]

[Means for Solving the Problem]In order to solve the above-mentioned technical problem, a nozzle formation member concerning this invention is considered as composition which has a part where angles at which an ink discharge direction and a tangential direction of nozzle hole inner skin make a nozzle hole differ by the ink discharge side and ink flow ON side side at least, and said angle changes continuously.

[0022]Here, as for thickness of a part which has the arbitrary angles by the side of an ink flow ON side, it is preferred to use one 1.0 to 2.0 times the thickness of this to thickness of a part which has a different angle from this. It is preferred to keep thickness of a part which has the arbitrary angles by the side of an ink discharge side from being less than 10 micrometers. The angle which an ink discharge direction and a tangential direction of nozzle hole inner skin make can also perform a paddle gap which makes the ink flow ON side side smaller than the ink discharge side side, or makes the ink flow ON side side larger than the ink discharge side side.

[0023]A nozzle formation member mentioned above is used for an ink jet head concerning this invention.

[0024]A manufacturing method of a nozzle formation member concerning this invention is a method of manufacturing a nozzle formation member mentioned above, After the surface forms the 1st photosensitive organic layer on a substrate which has conductivity and is exposed via the 1st mask member at least, form the 2nd photosensitive organic layer, and it exposes and ranks second via the 2nd

mask member, The these 1st and 2nd photosensitive organic layer is developed collectively, and after forming an organic film pattern of lamination in a part equivalent to a nozzle hole part, it has composition which forms a metal membrane.

[0025]Here, before forming a photosensitive organic layer after [2nd] exposing the 1st photosensitive organic layer, overheating processing of the 1st photosensitive organic layer can be carried out. It is preferred to use thickness thinner than thickness of an organic film pattern, and also after a metal membrane formed on a substrate forms a metal membrane, it is preferred to form a surface layer which has water repellence continuously. Bipolar membrane of PTFE and metal can be formed by an eutectoid plating method as a surface layer which has this water repellence.

[0026]It can become large conversely so that an angle which a normal line direction of a substrate face and a taper part of the 1st photosensitive organic layer exposed and developed make may become small compared with an angle which a normal line direction of a substrate face and a taper part of the 2nd photosensitive organic layer exposed and developed make.

[0027]

[Embodiment of the Invention]Hereafter, an embodiment of the invention is described with reference to an accompanying drawing. The typical section explanatory view of an ink jet in which drawing 1 applied this invention, and drawing 2 are the typical section explanatory views of the direction which intersects perpendicularly with drawing 1 of the head.

[0028]The electrode substrate 3 which provided this ink jet head in this diaphragm substrate 1 and diaphragm substrate 1 bottom via the gap member 2, Have the fluid chamber board 4 formed in the diaphragm substrate 1 upper part, and the nozzle plate 5 which is the nozzle formation members provided on this fluid chamber board 4, and Two or more nozzles 6, The flow-resistance part 9 etc. which open for free passage the regurgitation room 7 which each nozzle 6 opens for free passage, the common ink chamber 8 for supplying ink to each regurgitation room 7, and each regurgitation room 7 and the common ink chamber 8 are formed.

[0029]The crevice 12 which forms the diaphragm 11 which makes the regurgitation room 7 and the pars basilaris ossis occipitalis of this regurgitation room 7, the crevice 13 which forms the common ink chamber 8, the slot 14 which forms the flow-resistance part 9, etc. are formed in the diaphragm substrate 1. This diaphragm substrate 1 forms the pattern which constitutes a desired detailed fluid chamber from etching metal substrates, such as a SUS substrate, a silicon substrate, etc.

[0030]The individual electrode 15 which puts the predetermined gap formed by the gap member 2 on the electrode substrate 3, and counters the diaphragm 11 is laid underground, and the actuator section to which the diaphragm 11 is displaced and the content volume of the regurgitation room 7 is changed by this individual electrode 15 and diaphragm 11 is constituted. The protective film 16 which consists of an oxide film for preventing a short circuit with the diaphragm 11 etc., etc. is formed in the individual electrode 15 surface.

[0031]The penetrated parts 16 and 18 etc. which form the regurgitation room 7 and the common ink chamber 8 are formed in the fluid chamber board 4. And the nozzle plate 5 which has the nozzle 6 is formed on this fluid chamber board 4. The water-repellent surface layer 19 is formed in the ink discharge side side of this nozzle plate 5.

[0032]These diaphragm substrates 1, the gap member 2, the electrode substrate 3, the fluid chamber board 4, and the nozzle plate 5 are joined by direct junction, eutectic bonding, anode joining, junction by adhesives, etc.

[0033]In this ink jet head, the Coulomb force by an electric charge is generated by impressing a driving waveform to the individual electrode 15, and charging between the diaphragm 11 and the electrode 15, the diaphragm 11 is sagged in the electrode 15 side, and the capacity of the regurgitation room 7 is expanded. An ink droplet is breathed out from the nozzle 6 by the ink pressure which the diaphragm 11 returns according to that elastic restoring force, and the capacity in the regurgitation room 7 contracts it rapidly, and is generated from this state at this time by making the electric charge between the electrode 15 and the diaphragm 11 discharge rapidly.
[0034]And impress a driving waveform to the electrode 15 again, displace the diaphragm 11 to the electrode 15 side, and it holds in the state, Negative pressure arises in the regurgitation room 7 by expulsion of an ink droplet, and ink is supplied in the regurgitation room 7 through the ink feed path (flow-resistance part) 9 from the common ink chamber 8, and where the ink meniscus in the nozzle 6 is stabilized to some extent, it shifts to the following expulsion-of-an-ink-droplet distance.
[0035]Here, a 1st embodiment of the nozzle formation member concerning this invention which constitutes the nozzle plate 5 is described with reference to drawing 3. The figure (a) is an important section explanatory view near a nozzle hole, and the figure (b) is an important section enlarged drawing of (a).
[0036]The nozzle hole 31 which constitutes the nozzle 6 is formed in this nozzle formation member 30. This nozzle hole 31 forms smaller than the opening diameter of the opening (ink flow entrance) 33 by the side of an ink flow ON side the opening diameter (this is called "diameter of a delivery".) of the opening (ink discharge opening) 32 by the side of an ink discharge side, as shown in the figure (a).
[0037]This nozzle hole 31, The part 35 which forms the part 34 and the nozzle hole inner skin 31b which form the two nozzle hole inner skin 31a where the angles (this is marked at "the angle theta".) which the ink discharge direction of the nozzle formation member 30 and the tangential direction of nozzle hole 31 inner skin make differ by the regurgitation side and inflow side side, The boundary part of each of these peripheral surfaces 31a and 31b is formed by the part (this is called "intermediate part".) 36 formed continuously.
[0038]The angle at which an ink discharge direction and the tangential direction of inner skin make the ink hole inner skin 31a by the side of an ink discharge side here, That is, the angle formed by the line c and the line a is formed in the angle theta 1, and the ink hole inner skin 31b by the side of an ink flow ON side forms in the angle theta 2 the angle which an ink discharge direction and the tangential direction of inner skin make, i.e., the angle formed by the line c and the line b. These angles theta1 and theta2 are formed so that it may become without theta1>theta2.
[0039]Thus, the angle theta 2 of the tangential direction of the inner skin 31b of the part 35 by the side of an ink flow ON side, and an ink discharge direction to make, By what is made small compared with the angle theta 1 of the tangential direction of the inner skin 31a of the part 34 by the side of an ink discharge side, and an ink discharge direction to make (theta2<theta1), the inner skin 31a of the part 34 by the side of an ink discharge side can be formed in the reverse tapered shape represented by the figure.
[0040]And by using reverse tapered shape as mentioned above, when the meniscus position of the liquid ink side at the time of the regurgitation in expulsion of an ink droplet is set as the ink discharge opening side edge part of a nozzle hole, since the ink discharge opening side edge part is keen and the meniscus position of an ink droplet is easily controllable by the surface tension of a regurgitation side, and the edge effect of a delivery end to the ink discharge opening side edge part of a nozzle hole -- the regurgitation characteristic (jetting properties) of an ink droplet -- especially control of discharge

direction nature becomes easy.
[0041]As shown in the figure (b), have formed the intermediate part 36 where the angle theta changes in the middle of the part 34 by the side of the regurgitation side where the angles theta of the nozzle hole 31 differ, and the part 35 by the side of an inflow side, but. This intermediate part 36 is not keen and he is trying for the inner skin 31a and 31b where the angles theta differ to change continuously by giving a radius of circle and forming smoothly.
[0042]When it is considered as the thickness t2 of the part 35 which has the arbitrary angles theta 2 by the side of an ink flow ON side, and the thickness t1 of the part 34 which has the different angle theta 1 from this, the thickness t2 is increased 1.0 to 2.0 times to the thickness t1. By satisfying this relation, control of the diameter of a delivery (opening diameter of an ink discharge opening) when the manufacturing method concerning this invention mentioned later is used can become easy, and the expulsion-of-an-ink-droplet characteristic can be stabilized.
[0043]The thickness t1 of the part 34 which makes the angle theta 1 by the side of an ink discharge side is kept from being less than 10 micrometers. Thereby, control of the diameter of a delivery in the manufacturing process of a nozzle formation member can become easy, and the expulsion-of-an-ink-droplet characteristic can also be stabilized so that it may mention later.
[0044]Thus, the nozzle formation member 30 differs [angle / theta / at which an ink discharge direction and the tangential direction of nozzle hole inner skin make the nozzle hole 31] in the ink discharge side and ink flow ON side side at least, And since the angle theta had composition which has the intermediate part 36 which changes continuously, an expulsion-of-an-ink-droplet pressure can be efficiently told from an ink flow entrance side to the ink discharge opening side, the pressure loss by cellular ****** etc. decreases, and the expulsion-of-an-ink-droplet characteristic improves. When the size of an ink flow entrance side can be stopped and it attains the making narrow pitch between contiguity nozzles with it, the yield is good, and it enables control of a nozzle diameter to adopt an easy manufacturing method.
[0045]Next, a 2nd embodiment of the nozzle formation member concerning this invention is described with reference to drawing 4. The figure (a) is an important section explanatory view near a nozzle hole, and the figure (b) is an important section enlarged drawing of (a). In this nozzle formation member 30, conversely, a 1st embodiment of the above forms the angle theta 1 of the ink hole inner skin 31a of the nozzle hole 31, and the angle theta 2 of the ink hole inner skin 31b by the side of an ink flow ON side so that it may be set to theta1<theta2. Other composition is the same as that of a 1st embodiment.
[0046]Thus, the angle theta 2 which the tangential direction and ink discharge direction of the inner skin 31b of the part 35 by the side of an ink flow ON side make, as [represent / what is enlarged compared with the angle theta 1 which the tangential direction and ink discharge direction of the inner skin 31a of the part 34 by the side of an ink discharge side make (theta2>theta1) / at the figure / the inner skin 31a of the part 34 by the side of an ink discharge side] -- it can form in vertical shape mostly.
[0047]And when the meniscus position of the liquid ink side at the time of the regurgitation in expulsion of an ink droplet is set up inside the ink discharge opening end of a nozzle hole (direction approaching an ink flow entrance), Since the inner skin of the part 34 by the side of a regurgitation side is vertical shape mostly, even if the meniscus position of an ink droplet changes somewhat, the size of an oil level does not change, but the size and flight initial velocity of an ink droplet can be controlled, and, thereby, control of the expulsion-of-an-ink-droplet characteristic becomes easy.
[0048]Next, the case where the nozzle formation member of a 1st embodiment (drawing 3) of the above is manufactured is explained to an example with reference to drawing 5 thru/or drawing 7 about a 1st

embodiment of the manufacturing method of the nozzle formation member concerning this invention. The typical section explanatory view in which drawing 5 explains a manufacturing process, the flow chart where drawing 6 explains some process flows of the manufacturing process, and drawing 7 are the important section expansion explanatory views of an organic film pattern.

[0049]When it explains mainly with reference to drawing 5, as shown in the figure (a), conductive substrates, such as stainless steel, Or the 1st photosensitive organic layer 42 that used negative resist or a dry film resist for the substrate 41 which has the conductivity of the substrate etc. which formed the conductor film in the glass substrate surface by sputtering is formed, and heat-treatment before exposure is performed.

[0050]And as shown in the figure (b), via the 1st mask member 43, using a stuck type exposure machine or a reduction exposure machine, the 1st photosensitive organic layer 42 is exposed and the 1st exposure process that forms the sensitization field 44 in a nozzle hole formation point with the arbitrary paths near the diameter of input is performed.

[0051]Subsequently, as shown in the figure (c), following on the 1st exposure process, the 2nd photosensitive organic layer 45 that used negative resist or a dry film resist on the 1st sensitization organic layer 42 is formed, and heat-treatment before exposure is performed.

[0052]And as shown in the figure (d), via the 2nd mask member 46, using a stuck type exposure machine or a reduction exposure machine, the 2nd photosensitive organic layer 45 is exposed and the 2nd exposure process that forms the sensitization field 47 in a nozzle hole formation point with the arbitrary paths near the diameter of a delivery is performed.

[0053]Then, as shown in the figure (e), the 1st photosensitive organic layer 42 and the 2nd photosensitive organic layer 45 are developed collectively, the organic film pattern 48 of lamination is formed in the part equivalent to a nozzle hole part, and after-development overheating processing is performed.

[0054]And as are shown in the figure (f), and the metal membranes 49, such as nickel or nickel-Co alloy, are formed with electroforming etc. on the substrate 41 along with the organic film pattern 48 laminated by the part equivalent to a nozzle hole and it is shown in the figure (g), The substrate 41 which has conductivity, and the organic film pattern 48 of lamination are removed, and the nozzle formation member 30 which has the nozzle hole 31 is obtained.

[0055]When exposing here using the stuck type exposure machine which has the wavelength of g line, for example, as shown in drawing 7, the portion used as the part 51 by the side of the regurgitation side of the lamination organic film pattern 48, By increasing the light exposure of this exposure machine by using the 2nd mask material 46 as a mask, the diffraction effect of light increases, and negatives are exposed and developed by forward tapered shape shape.

[0056]And the portion used as the intermediate part 53 of the lamination organic film pattern 48 is exposed and developed in the shape (shape which has a radius of circle) which changes continuously the angle which nozzle hole inner skin and an ink discharge direction make by the edge effect at the time of a surroundings lump and development of the light at the time of the above-mentioned exposure (effect that development tends to follow a corner).

[0057]By optimizing the light exposure of this exposure machine by using the 1st mask material 43 as a mask, the diffraction effect of light is inhibited, and the portion used as the part 52 by the side of the inflow side of the lamination organic film pattern 48 is mostly exposed and developed by vertical shape.

[0058]Thus, the nozzle formation member which has a nozzle hole which has an intermediate part where

the angles theta which an ink discharge direction and the tangential direction of nozzle hole inner skin make differ by the ink discharge side and ink flow ON side side at least, and the angle theta changes continuously is obtained.

[0059]And by exposing the 1st photosensitive organic layer with the size near the diameter of input according to the 1st exposure process, exposing the 2nd photosensitive organic layer with the size near the diameter of a delivery according to the 2nd exposure process, and developing the 1st and 2nd photosensitive organic layer collectively, The organic film pattern shape which has a part equivalent to the intermediate part which has a radius of circle (the angle of the tangential direction and ink discharge direction of nozzle hole inner skin changes continuously) can be obtained. At this time, the 2nd photosensitive organic layer that becomes comparatively thin especially can be exposed with the light exposure which is generous to a resolution limit, size control of the part equivalent to a delivery becomes easy, and the nozzle which has a highly precise diameter of a delivery can be obtained.

[0060]Although the example using the resist of the negative mold as a photosensitive organic layer explained, even if it uses the resist of a positive type by changing a mask material and an exposing condition, a same-shaped organic film pattern can be obtained.

[0061]Although the manufacturing method of the nozzle formation member which has the nozzle hole 31 shown in drawing 3 is explained, it is applicable also like the manufacturing method of the nozzle formation member which has the nozzle hole shown, for example in drawing 4. In this case, it becomes possible to form in the part equivalent to the target nozzle hole the lamination organic film pattern of the shape made into the purpose by optimizing the exposing condition of the part 51 by the side of the regurgitation side shown in drawing 7, and the part 53 by the side of an inflow side.

[0062]that is, in drawing 5 (e) and drawing 7, it is formed by the normal line direction (a direction vertical to a substrate face: the direction of the line C) of the substrate 41 surface, and the 1st photosensitive organic layer 42 exposed and developed -- inclining (the line B shows) -- angle sigma2 which the taper part 52 which it has makes, By forming the organic film pattern 48 so that it may become small compared with angle sigma1 which the normal line direction of the substrate 41 surface and the taper part 51 which has the inclination (the line A shows) formed by the 2nd photosensitive organic layer 45 exposed and developed make. The nozzle formation member which has a nozzle hole where the angle theta 2 of the inner skin shown in drawing 3 becomes small to the angle theta 1 can be obtained.

[0063]Angle sigma2 [on the other hand,] which the normal line direction of the substrate 41 surface and the taper part 52 which has the inclination formed by the 1st photosensitive organic layer 42 exposed and developed make in drawing 5 (e) and drawing 7, By forming the organic film pattern 48 so that it may become large compared with angle sigma1 which the normal line direction of the substrate 41 surface and the taper part 51 which has the inclination formed by the 2nd photosensitive organic layer 45 exposed and developed make. The nozzle formation member which has a nozzle hole where the angle theta 2 of the inner skin shown in drawing 4 becomes large to the angle theta 1 can be obtained.

[0064]Here, the relation between the thickness t1 of the part 33 by the side of the regurgitation side shown in drawing 3 and drawing 4 which were mentioned above and the thickness t2 of the part 34 by the side of an inflow, and a manufacturing process, etc. are explained. He is trying for the thickness t2 of the part 35 which has the arbitrary angles by the side of an ink flow ON side to increase 1.0 to 2.0 times to the thickness t1 of the part 34 which has an angle different [inflow side side by the side of an ink

discharge side], as mentioned above.
[0065]For example, when 80 micrometers of thickness of the manufacture top of a nozzle formation member and a nozzle formation member are required, By the thickness t2 by the side of the inflow side which forms the thickness t1 by the side of the regurgitation side formed by the 2nd photosensitive organic layer 45 by 30 micrometers and the 1st photosensitive organic layer 42 being 50 micrometers (they are about 1.6 times to t1), What is necessary is just to make the photosensitive organic layer of the thickness of 30-micrometer thickness resolve to the diameter of a delivery of the diameter of 30 micrometer at the time of the 2nd exposure in the manufacturing process mentioned above.
[0066]In this case, since the diameter of a delivery of a nozzle is formed by the part in the middle of the pattern of the 2nd photosensitive organic layer 45 as shown in drawing 6, the shape controlling of the pattern of the 2nd photosensitive organic layer 45 becomes important at control of the diameter of a delivery, but. Since the thickness t1 by the side of a regurgitation side is 30 micrometers, a leeway is enough given in the resolution limit of the photosensitive organic layer 45, control of the diameter of a delivery becomes easy, it is controlled with **, and the yield improves.
[0067]On the other hand, the thickness t2 of the part 35 which has the arbitrary angles by the side of the ink flow ON side of a nozzle formation member, When it is only less than 1.0-time thickness to the thickness t1 of the part 34 which has an angle different [inflow side side by the side of an ink discharge side], For example, 80 micrometers of manufacture episporium thickness of a nozzle formation member are required, and when the thickness t2 by the side of 50 micrometers and an inflow side is t1 30 micrometers for the thickness by the side of a regurgitation side, the photosensitive organic layer 45 of the thickness exceeding 50-micrometer thickness must be resolved to the diameter of a delivery of 30 micrometers at the time of the 2nd exposure. In this, a margin will be lost to the resolution limit of the 2nd photosensitive organic layer 45, control of the diameter of a delivery will become difficult, dispersion will increase, and the yield will fall.
[0068]The thickness t2 of the part 35 which has the arbitrary angles by the side of the ink flow ON side of a nozzle formation member, When it has the thickness which exceeds 2.0 times to the thickness t1 of the part 34 which has an angle different [inflow side side by the side of an ink discharge side], For example, 60 micrometers of manufacture episporium thickness of a nozzle formation member are required, and when the thickness t1 by the side of 45 micrometers and a regurgitation side is 15 micrometers the thickness t2 by the side of an inflow side, the thickness by the side of a regurgitation side turns into comparatively thin thickness. Since a resolving margin increases by as mentioned above at the time of exposure of the above 2nd at this time, while control of the diameter of a delivery becomes easy, it may cause a jetting-properties (regurgitation characteristic) fall as follows.
[0069]Namely, if it is made to inject by on demand one from two or more nozzles, respectively when driving an ink jet head and making an ink droplet breathe out from a nozzle, the meniscus position of each nozzle will usually change in the range of the about 20-micrometer depth from a delivery end. Therefore, as mentioned above, the fluctuation range of meniscus will not be settled in the range by the side of the regurgitation side of a nozzle hole as the thickness by the side of a regurgitation side is 15 micrometers and comparatively thin thickness, but it will go into the inflow side side, and as a result, injection performance may fall. If the thickness t1 by the side of a regurgitation side is less than 10 micrometers especially, the fall of jetting properties will become remarkable.
[0070]Therefore, it is preferred that the thickness t2 of a part which has the arbitrary angles by the side of the ink flow ON side of a nozzle formation member uses one 1.0 to 2.0 times the thickness of this to

the thickness of the part t1 which has an angle different [inflow side side by the side of an ink discharge side]. As for the thickness of the part by the side of a regurgitation side, it is preferred to make it not less than 10 micrometers. Although the thickness of the part by the side of this regurgitation side is not limited to not less than 10 mm, it is preferred that a meniscus face is the thickness which does not go into the part by the side of an inflow.

[0071]Next, a 2nd embodiment of the manufacturing method of the nozzle formation member concerning this invention is described with reference to drawing 8. The figure is a flow chart which illustrates some process flows of the manufacturing process like drawing 6. In this embodiment, before forming the 2nd photosensitive organic layer 45 after performing the 1st exposure process that exposes the 1st photosensitive organic layer 42 at the process (refer to drawing 6) of a 1st embodiment of the above, the heat-treatment process of carrying out overheating processing of the 1st photosensitive organic layer 42 is added. Other processes are the same as that of a 1st embodiment.

[0072]Thus, by performing afterbaking processing which exposed the 1st photosensitive organic layer 42, The crosslinking reaction of the 1st photosensitive organic layer 42 is promoted arbitrarily, and the shape of the 1st photosensitive organic layer 42 in the intermediate part 53 of the lamination organic film pattern 48 can be controlled in arbitrary shape at the time of the 2nd exposure and development.

[0073]In this case, although it can replace with negative resist and a positive resist can also be used, in the case of a positive type, combination of the organic matter which constructed the bridge by heat-treatment comes to go out.

[0074]Next, drawing 6 (f) mentioned above about a 3rd embodiment of the manufacturing method of the nozzle formation member concerning this invention is made reference, and is explained. According to this embodiment, thickness of the metal membrane 49 formed on the substrate 41 which has conductivity along with the organic film pattern 48 laminated by the part equivalent to a nozzle hole is made thinner than the thickness of the lamination organic film pattern 48.

[0075]The delivery of the metal membrane 49 formed by electroforming etc. is prescribed by this by the peripheral diameter by the side of the regurgitation side of the organic film pattern 48, and control of the shape of a delivery and a path becomes easy.

[0076]Next, a 4th embodiment of the manufacturing method of the nozzle formation member concerning this invention is described also with reference to drawing 9. The figure shows drawing 6 (f) or subsequent ones. That is, as shown in drawing 9 (a), after forming the metal membrane 49 with electroforming, by forming the bipolar membrane of metal and PTFE continuously by an eutectoid plating method, the water-repellent surface layer 50 is formed, the lamination organic film pattern 48 and the substrate 41 are removed after that, and the nozzle formation member 30 is obtained.

[0077]Thus, expulsion of an ink droplet where the expulsion-of-an-ink-droplet characteristic was improved and stabilized can be performed by forming a water-repellent surface layer. Manufacture becomes easy by forming by the eutectoid plating method of metal and PTFE especially.

[0078]Next, the different example is explained with reference to drawing 10 and drawing 11 about a concrete example. First, the 1st example shown in drawing 10 is manufactured by the embodiment described by drawing 8, and the metal membrane 49 forms membranes with the electroforming of nickel, and forms the water-repellent surface layer 50 which continues at this nickel electrocasting, performs eutectoid plating of nickel and PTFE, and consists of a nickel-PTFE eutectoid film.

[0079]In the nozzle hole 31 of this 1st example, the diameter of a delivery was 25 micrometers, the

diameter of input was 75 micrometers, and the thickness t1 by the side of a regurgitation side set thickness t2 by the side of 30 micrometers and an inflow side to 50 micrometers. The angle theta 1 which the tangential direction and ink discharge direction of the inner skin 31a by the side of a regurgitation side make is about 15 degrees, and the angle theta 2 which the tangential direction and ink discharge direction of the inner skin 31b by the side of an inflow side make is about 5 degrees. The width of the intermediate part 34 which changes this angle theta continuously was about 12 micrometers.

[0080]Here, in order for the angle theta 1 which the tangential direction and ink discharge direction of the inner skin by the side of a regurgitation side make to be about 15 degrees, the exposing condition in drawing 5 (d) was made into excess exposure, and the forward tapered shape shape of the resist by the side of a regurgitation side was obtained using the diffraction effect of light. The opening diameter of the 2nd mask material 46 used at this time was 20 micrometers.

[0081]moreover -- considering the exposing condition in drawing 5 (b) as suitable exposure, and inhibiting the diffraction effect of light, in order for the angle theta 2 which the tangential direction and ink discharge direction of the inner skin by the side of an inflow side make to be about 5 degrees -- the resist by the side of an inflow side -- vertical shape has been acquired mostly. The opening diameter of the 1st mask material used at this time was 70 micrometers.

[0082]Next, the 2nd example shown in drawing 11 is also manufactured by the embodiment described by drawing 8, and the metal membrane 49 forms membranes with the electroforming of nickel, and forms the water-repellent surface layer 50 which continues at this nickel electrocasting, performs eutectoid plating of nickel and PTFE, and consists of a nickel-PTFE eutectoid film.

[0083]In the nozzle hole 31 of this 2nd example, the diameter of a delivery was 25 micrometers, the diameter of input was 75 micrometers, and the thickness t1 by the side of a regurgitation side set thickness t2 by the side of 30 micrometers and an inflow side to 50 micrometers. The angle theta 1 which the tangential direction and ink discharge direction of the inner skin 31a by the side of a regurgitation side make is about 5 degrees, and the angle theta 2 which the tangential direction and ink discharge direction of the inner skin 31b by the side of an inflow side make is about 15 degrees. The width of the intermediate part 34 which changes this angle theta continuously was about 10 micrometers.

[0084]considering an exposing condition for the exposing condition in drawing 5 (d) as suitable exposure, and inhibiting the diffraction effect of light, in order for the angle theta 1 which the tangential direction and ink discharge direction of the inner skin by the side of a regurgitation side make to be about 5 degrees here -- the resist by the side of a regurgitation side -- vertical shape has been acquired mostly. The opening diameter of the 2nd mask material 46 used at this time was 25 micrometers.

[0085]In order for the angle theta 2 which the tangential direction and ink discharge direction of the inner skin by the side of an inflow side make to be about 15 degrees, it was considered as the excess exposure in drawing 5 (b), and the forward tapered shape shape of the resist by the side of an inflow side was obtained using the diffraction effect of light. The opening diameter of the 1st mask material used at this time was 50 micrometers.

[0086]Since the negative resist which is the 1st photosensitive organic layer as heat-treatment is heat-treated after the 1st exposure, the crosslinking reaction of the 1st photosensitive organic layer is promoted, and the quantity by which the 1st photosensitive organic layer of the intermediate part

neighborhood is exposed at the time of the 2nd exposure is controlled.
[0087]Although the nozzle formation member concerning this invention explained at the above-mentioned embodiment in the example which is a nozzle formation member of an ink jet head, it does not restrict to this. Although the example applied to an electrostatic type ink jet head and its nozzle plate as an ink jet head explained, heating resistors, piezoelectric elements, etc. other than this are applicable also to the ink jet head used for an energy generation means, and its nozzle formation member.
[0088]Although the example in case nozzle hole inner skin has two different angles by the ink discharge side and ink flow ON side side explained in the above-mentioned embodiment, three or more different angles can also be given and, thereby, improvement in the expulsion-of-an-ink-droplet characteristic can be aimed at further.
[0089]
[Effect of the Invention]As explained above, according to the nozzle formation member concerning this invention, a nozzle hole, Since it has a part where the angles which an ink discharge direction and the tangential direction of nozzle hole inner skin make differ by the ink discharge side and ink flow ON side side at least, and said angle changes continuously, the expulsion-of-an-ink-droplet characteristic can be improved, and it can respond also to the making narrow pitch between contiguity nozzles.
[0090]Here, by using one 1.0 to 2.0 times the thickness of this to the thickness of the part which has an angle which is different from this in the thickness of the part which has the arbitrary angles by the side of an ink flow ON side, control of the diameter of a delivery in a manufacturing process becomes easy, and can also control the fall of the expulsion-of-an-ink-droplet characteristic. The fall of the expulsion-of-an-ink-droplet characteristic can be controlled by keeping the thickness of the part which makes the angle by the side of an ink discharge side from being less than 10 micrometers.
[0091]rather than the ink discharge side side, it is things small, and control of the discharge direction of an ink droplet becomes easy, or the angle which an ink discharge direction and the tangential direction of nozzle hole inner skin make the ink flow ON side side, By making the ink flow ON side side larger than the ink discharge side side, control of ink droplet volume and initial velocity becomes easy.
[0092]Since the nozzle formation member mentioned above was used according to the ink jet head concerning this invention, the expulsion-of-an-ink-droplet characteristic can be improved, and it can plan to densification by the making narrow pitch between contiguity nozzles.
[0093]According to the manufacturing method of the nozzle formation member concerning this invention, it is the method of manufacturing the nozzle formation member mentioned above, Form the 1st photosensitive organic layer on a substrate, and it exposes via the 1st mask member, Form the 2nd photosensitive organic layer following this, and it exposes via the 2nd mask member, Since the these 1st and 2nd photosensitive organic layer is developed collectively, the organic film pattern of lamination is formed in the part equivalent to a nozzle hole part and a metal membrane is formed along with the organic film pattern laminated by the part equivalent to this nozzle hole part, Size control of the part which can manufacture easily the nozzle formation member which has a part where the angles which an ink discharge direction and the tangential direction of nozzle hole inner skin make differ by the ink discharge side and ink flow ON side side at least, and said angle changes continuously, and is equivalent to a delivery becomes easy.
[0094]Here, by heat-treating, before forming the photosensitive organic layer after [2nd] exposing the 1st photosensitive organic layer, the crosslinking reaction of the 1st photosensitive organic layer can be promoted, and the shape controlling of the boundary part of the 1st photosensitive organic layer of a

lamination organic film pattern and the 2nd photosensitive organic layer becomes easy.
[0095]By forming the metal membrane formed on a substrate along with the organic film pattern laminated by the part equivalent to a nozzle hole part by thickness thinner than the thickness of an organic film pattern, control of the diameter of a delivery becomes easy and a highly precise nozzle hole can be obtained. After forming a metal membrane, the expulsion-of-an-ink-droplet characteristic can be improved by forming the surface layer which has water repellence continuously.
[0096]It is forming the bipolar membrane of PTFE and a metal membrane by an eutectoid plating method as a surface layer which has this water repellence, and formation of a water-repellent surface layer is easy, and can also reduce cost.
[0097]it is made for the angle which the normal line direction of a substrate face and the taper part of the 1st photosensitive organic layer exposed and developed make to become small compared with the angle which the normal line direction of a substrate face and the taper part of the 2nd photosensitive organic layer exposed and developed make, [come out and] The angle by the side of an inflow side can form a small nozzle hole easily as compared with the angle by the side of a regurgitation side, conversely, it is made for the angle which the normal line direction of a substrate face and the taper part of the 1st photosensitive organic layer exposed and developed make to become large compared with the angle which the normal line direction of a substrate face and the taper part of the 2nd photosensitive organic layer exposed and developed make, [come out and] The angle by the side of an inflow side can form a large nozzle hole easily as compared with the angle by the side of a regurgitation side.

[Translation done.]